

FOCUS

Environmental Problems behind the Great Wall

China is a rapidly developing country with one-fifth of the world's population. The country faces major social and political problems, which have gained the world's attention. Equally challenging are serious environmental problems resulting from overpopulation, rapid industrialization, and overuse of natural resources that could potentially threaten the health of China's 1.2 billion people, whether they live in cities or the rural countryside.

The most serious environmental health problem, say Chinese environmental health experts, is air pollution. One example is Taiyuan, the capital of Shanxi Province and an ancient fortified city located in a valley. Iron, steel, and chemical factories spew soot, fly ash, and sulfur dioxide into the air, and the pollutants are trapped within the valley

and the walls of the city, according to the Chinese National Environmental Protection Agency (NEPA). Two million people live in Taiyuan.

Indoor air pollution is also a serious threat. Women in rural Xuan Wei County of Yunnan Province have the highest lung cancer rate among Chinese women, even though few smoke. The greatest cancer risk is among residents who burn smoky coal inside their homes with no ventilation. The Chinese Academy of Preventive Medicine says thousands of Chinese in other rural areas suffer debilitating diseases from burning coal containing arsenic and fluoride. Most factories built before the 1980s have no pollution control equipment and are fueled by coal, which the government calls "the chief source of air pollution in China."

According to Vaclav Smil, professor and author of *China's Environmental Crisis*, "Burdens of air pollution are not surprising in a nation where combustion of one billion tons of coal, largely uncleaned and burned with minimal or no pollution controls, supplies three-quarters of all primary energy." As a result, numerous cities in China exceed World Health Organization air pollution guidelines.

Statistics show high morbidity and mortality from lung disease in China. Respiratory disease is one of the leading causes of death overall in China. It is the primary cause of death among rural residents, who have a mortality rate of 168 per 100,000 people. Cancer is the primary cause of death among urban residents, who have a mortality rate of 126 per 100,000 according to the 1992 *Report on the State of the Environment in China*, published by NEPA. "Environmental pollution and unhealthy habits are the main causes of disease," the report concludes. "Unhealthy habits" include smoking—a habit shared by 300 million Chinese. An estimated two million Chinese a year will die from smoking by the year 2025 if the current rate of tobacco use persists.

China's second most serious environmental health problem is water pollution. Waterborne illnesses, from sewage and agricultural waste contaminating the water supplies, cause thousands of deaths from infectious disease per year. Rivers used for drinking water also become polluted with industrial discharges, according to Bai Changbo, NEPA's Foreign Affairs Officer. Says Changbo, "Much of China's surface water is contaminated with heavy metals, including lead, cadmium, and arsenic, from industrial effluent."

Economy versus Environment

At the same time that even state-run enterprises are fouling the air and water, the government is moving full-steam ahead on economic reforms and its plans for rapid expansion. For example, a \$700-million petrochemical plant is under construction in the port city of Tianjin, described by the *Wall Street Journal* in an article 4 August 1993 as "the first of 14 [chemical] plants China plans to build by 1996." With increasing foreign investment and skyrocketing growth rates (China now boasts a GNP ranked by some as third in the world), the standard of living for China's 1.2 billion people is rapidly rising.

Even the government admits that the country is paying a price for its rapid



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Smoking gun. Women in Xuan Wei who cook with smoky coal have the highest lung cancer incidence of Chinese women.

growth. "While the government is putting more and more attention on environmental pollution, industry is attaching more importance to economic development," says Changbo, adding that both state-run and joint ventures often ignore the strict standards NEPA sets. "If you talk with the manager of an enterprise, the first question is about production and money; you have to remind him to consider the environment," said Changbo. That attitude could change as China seeks international help for its environmental problems. Already the World Bank has committed record amounts of money to China, \$300 million in 1993 alone, to strengthen the government's environmental protection programs.

By urging Chinese enterprises to be more environmentally responsible, some U.S. firms also hope to turn a profit. In Beijing, American businessman Husayn Anwar has set up an environmental consulting firm, emphasizing the long-term cost-effectiveness of pollution control. Other companies hope to locate markets for emission control devices. *Fortune* magazine reported 23 August 1993 that a delegation of American firms visited China in June 1993 to evaluate demand for their coal-cleaning equipment.

Ambient Air Pollution

The rising standard of living and influx of business people and tourists means more automobiles in China—and dirtier air. In 1992, one million vehicles were manufactured in China. In Beijing today there are 11 million people, 8 million bicycles, and fewer than 1 million cars. But that's six times as many cars as just two years ago. Now at rush hour the city has bumper-to-bumper traffic, with bicyclists fighting 25,000 taxis.

Cars in China run only on leaded gasoline. The mean blood lead levels of residents in major cities already appear to be slightly higher than in the United States, although few comprehensive studies have been conducted on sources of lead exposure. More cars with leaded gasoline will add to the lead body burden.

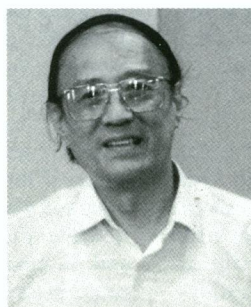
For now, the two main sources of air pollution are industrial emissions and the burning of coal (in homes, industry, and power plants), and the two most significant air pollutants are suspended particulate matter and sulfur dioxide. Annual mean ambient air levels of total suspended particulates (TSP) in U.S. cities typically are between 30 and 75 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). NEPA reports annual daily averages of 403 $\mu\text{g}/\text{m}^3$ in northern Chinese cities and 243 $\mu\text{g}/\text{m}^3$ in southern cities. In 1987 the EPA abandoned its TSP standard of 75 $\mu\text{g}/\text{m}^3$ in favor of a PM_{10} standard (TSPs smaller than 10 microns) of 50

$\mu\text{g}/\text{m}^3$. William Hunt, chief of EPA's Monitoring and Reports Branch, says the Chinese do not yet monitor for PM_{10} , so they are unable to look at the particles of greatest concern—those smaller than 10 microns—which can more deeply penetrate the lung.

For sulfur dioxide, NEPA reports an annual average of 95 $\mu\text{g}/\text{m}^3$ in large urban areas of China; in U.S. cities the annual average for sulfur dioxide levels is 21 $\mu\text{g}/\text{m}^3$. The EPA's annual mean standard for sulfur dioxide is 80 $\mu\text{g}/\text{m}^3$. NEPA says southern Chinese cities suffer frequent acid rain because of the sulfur dioxide emissions, which also present a global threat.

Ambient levels of sulfur dioxide and TSPs rise when coal is burned inside homes. According to Niu Shiru, honorary director of the Institute of the Environment and Engineering at the Chinese Academy of Preventive Medicine, Beijing has two peaks of ambient sulfur dioxide: one at breakfast time and the second at dinner. In a joint Harvard University–Beijing Medical University study, researchers Xu Xiping and Wang Lihua reported that high indoor and outdoor particulate levels in Beijing were related to increased chronic respiratory illness. Another study in Beijing found that a doubling of the ambient sulfur dioxide levels raised the risk of mortality by 11%.

EPA epidemiologist Robert Chapman and colleague William Wilson are studying acids and particulates in the ambient air of four Chinese cities. Their initial work (in collaboration with local environmental officials in China and U.S. scientist Paul Lioy),



Niu Shiru—Millions of Chinese people are being exposed to environmental contaminants.

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measured lung function of children attending schools in the urban core of Wuhan, China's fifth largest city, and in a suburb. Similar percentages of children from each area lived in homes with smokers and with coal heating. Coal emissions were often vented to the streets. In 1988, TSP levels averaged 251 $\mu\text{g}/\text{m}^3$ near children's homes in the urban core and 110 $\mu\text{g}/\text{m}^3$ in the suburb. By contrast, U.S. levels in urban areas average 30–75 $\mu\text{g}/\text{m}^3$. Levels of sulfur dioxide and nitrogen oxides were also

higher in the city core.

Initial results show that pulmonary function was lower in urban than in suburban children. They also show that boys and girls have similar lung function in second grade, but that by sixth grade, the girls' average level has dropped 15%, and for boys, 5%. Wilson says the results suggest that urban air pollution exposure in China contributes to retarded development of children's lungs. Longitudinal studies are underway.

Other industrial emissions also create air pollution threats. For example, arsenic emissions from metal smelting operations and foundries are creating "community pollution" in an area of Yunnan Province known for its tin mines, according to Beijing Medical University professor Wang Zhengang. Studies in the 1980s showed that tin miners have an increased risk of lung cancer, associated with exposure to inorganic arsenic and radon (along with smoking). "Now 400 residents in Gejiu suffer from arsenic poisoning and skin keratoses from exposure to arsenic in air and surface waters," says Wang. His research



Jed Waldman

Flunking the test. Schoolchildren in Wuhan suffer reduced lung function.

group at Beijing Medical University is also studying blood lead levels among residents who live near the smelters and foundries.

Indoor Air Pollution

The air inside Chinese homes often is significantly worse than the air outside. One study measured levels of sulfur dioxide as high as 860 $\mu\text{g}/\text{m}^3$ in urban homes with coal stoves (compared to the national average of 95 $\mu\text{g}/\text{m}^3$ in ambient air and the U.S. annual mean of 21 $\mu\text{g}/\text{m}^3$.) In one study, adults living in residential areas of Beijing (where coal stoves are used by half of the residents) were found to suffer reduced pulmonary function.

Visitors to Beijing are struck by the sight of piles of coal briquettes stacked against walls of homes and restaurants. Zhang Ji-Qiang, senior advisor for the Rockefeller Foundation's Global Environment Program, credits the Chinese Ministry of Agriculture with having developed a more efficient coal briquette than the ones currently used in Beijing. The new ones are made of smokeless, powdery coal mixed with clay and are designed to reduce particulate emissions by 75% when used properly. Zhang says a demonstration project is underway in 100 counties.

In rural areas, many families burn coal or wood, without ventilation, in shallow pits dug in the floor. Culture and customs have made the unventilated pits an important part of rural life, says Zhang. "Meals are cooked on the fire, people share stories of their day, pipes are smoked around the pit, food is dried above the fire, and beds are warmed by the heat. There is even a fire goddess whom some worship."

Lung cancer, smoky coal, and PAHs. Xuan Wei county has one million people, most of them farmers, who use unventilated stoves or pits like the ones described by Zhang. The area has provided a unique research setting for studying the health effects of three fuels: smoky coal, smokeless coal, and wood. In addition, the population is stable, there are few industrial facilities, and the county has one of the highest lung cancer rates in China.

Professor He Xingzhou and his colleagues at the Chinese Academy of Preventive Medicine's Institute of Environmental Health and Engineering began studying Xuan Wei in the 1970s; EPA researchers joined as investigators in 1982. He's landmark work, much of it in collaboration with EPA scientists Robert Chapman, Judy Mumford, and colleagues, demonstrates that nonsmoking women exposed to indoor coal smoke have an extremely high risk of lung cancer. Less than 1% of the Xuan Wei women smoke. In one of the smoky coal-burning communes of Xuan Wei, women had a lung cancer rate of 126 per 100,000 women—21 times higher than the 6 per 100,000 rate of women in the United States. The rate for men was four times higher than that for U.S. males.

Levels of suspended particulates inside homes burning coal were as high as 24.2 $\mu\text{g}/\text{m}^3$, 35 times higher than the peak levels currently found outdoors in the most polluted Chinese cities. Everyone in a family is exposed to the smoke, says He, but women generally spend more time inside the home, and they traditionally do the cooking. During the last decade, many of the Xuan Wei homes have installed chimneys to vent

coal and wood smoke.

The Chinese/EPA collaborative research is an interdisciplinary project involving epidemiology, environmental measurements, chemistry, and toxicology. Chapman says one of the investigators' major challenges now is to analyze coal samples and the complex chemical mixtures of coal combustion products collected in Xuan Wei.

Toxicologic studies by Mumford and colleagues JoEllen Lewtas and Jane Gallagher found that extracts of indoor air particles (measuring less than 10 microns) containing polycyclic aromatic hydrocarbons (PAHs) from Xuan Wei homes are potent tumor initiators in mice. They are now studying DNA adducts as qualitative biomarkers for human exposure to PAHs in the Xuan Wei population. A recent study showed detectable DNA adducts in a higher percentage of Xuan Wei women exposed to smoky coal or wood dust than in Beijing women using natural gas.

Among urban residents, indoor air pollution from coal also plays a role in high cancer rates. Researchers studied women in Shenyang, which has one of the highest lung cancer rates in China. Their study found that 35% of the cancers were related to smoking, but it also implicated air pollution from coal-burning stoves underneath brick beds ("kang"), as well as cooking-oil emissions.

Air quality will improve only if homes stop uncontrolled use of coal for fuel. But a full-scale changeover is not likely to happen soon. A government report observes: "Coal will continue to be China's primary source of energy for a considerable length of time, so in the absence of major breakthroughs in combustion technology and in coal conversion, atmospheric pollution and the acid rain hazard are likely to worsen."

Arsenic in air. Some geographical areas of China contain naturally high levels of arsenic and fluoride. Concerned about the effects of exposures to arsenic and fluoride on rural villagers, Professor Niu traveled to several Western countries in 1993, trying to interest scientists in examining the problems. The most serious arsenic exposures, Niu says, occur when villagers burn arsenic-tainted coal in open stoves.

One of the most severely affected areas is Guizhou Province, where Niu estimates two million people are exposed to dangerous levels of arsenic in the indoor air. Some villagers in the province, one of China's poorest, also drink arsenic-tainted water. People exposed to arsenic in the area are reported to develop keratoses and skin cancer.

Fluoride in air. Niu and his colleagues are also studying two types of fluorosis induced by exposure to excessive fluoride in food, water, or smoke: dental and skeletal



Andrea Hricko

Odds stacked against them. Coal briquettes stacked against a restaurant in Beijing are a reminder of the cause of China's worst air pollution.

fluorosis. Dental fluorosis results in mottling (pitting or staining) of teeth; skeletal fluorosis results in spinal deformities that cause a permanently stooped-over posture in adults. Researchers at the Institute of Environment and Engineering say in some remote villages nearly all residents have skeletal fluorosis, although some of these abnormalities are detectable only by X-ray. According to Niu, "Millions of people are exposed to excessive fluoride in water, food, and air in Sichuan Province alone." Professor He adds, "Some people are exposed when they hang corn to dry inside their homes; particulates that settle on the corn may be contaminated with fluoride or arsenic."

Research on Other Indoor Pollutants

A study in Beijing Medical University found levels of carbon monoxide as high as 47 ppm in homes using coal for heating, a level almost as high as the U.S. OSHA 8-hour standard of 50 ppm for workplace exposures. When central heating was introduced to some homes, levels of carbon monoxide dropped dramatically.

In Shenyang, researchers linked the number of meals deep-fried in oil (and the smokiness when cooking) to the risk of lung cancer. Researchers from the Shanghai Cancer Institute and the U.S. National Cancer Institute analyzed condensates from cooking oil-emissions (rapeseed and soya oils) and found they were toxic to humans. The researchers suggested reducing cooking temperatures to prevent exposures.

David Christiani and colleagues at Harvard are looking at pesticide exposure in a rural county of Anhui Province, where large quantities of organophosphates and carbamates are used. One issue they are exploring is whether children are exposed to pesticides in the home through contact with parents' contaminated clothing.

China has large deposits of asbestos, and occupational studies have found increased cancer and respiratory disease among workers. Investigators also have discovered indoor and outdoor asbestos exposure in a rural southwestern community, Da-yao. The land surface is naturally composed of soil and crocidolite asbestos, which villagers call "blue clay." Residents used the clay to stucco houses, pave roads, and build stoves, which were later discarded on the land. Of 2000 residents examined, 16 had asbestosis and 232 had pleural plaques.

Water Pollution

Most cities and villages do not have sophisticated sewage treatment facilities, so water supplies often become contaminated with bacteria and viruses. Sewage contamination of a sea bed from which clams were harvested was associated with 300,000 cases of

ARSENIC IN DRINKING WATER

A 77-year-old farmer sitting on a makeshift stool in Ilan County in northeastern Taiwan has no inkling of his role in the international environmental health debate concerning what is a safe level of arsenic in drinking water. For years the farmer drank artesian well water, which he learned too late contained high levels of inorganic arsenic. Now he has blackfoot disease, a peripheral vascular problem which required amputating his legs. Meanwhile in the United States, a court order has demanded that the U.S. EPA set a new standard for arsenic in drinking water by September 1994.

Almost 200 miles away from the farmer, an area on the southwest coast of Taiwan is dubbed the "blackfoot disease endemic area" because so many farmers have the disease. Studies of the area document a link between blackfoot disease and arsenic in drinking water. Even more significant are studies showing a high rate of skin cancer and increases in internal cancers associated with ingesting arsenic in drinking water.

Epidemiologist Chen Chien-Jen of National Taiwan University in Taipei has been studying the blackfoot disease endemic area for years. Says Chen, "We have found a strong dose-response relationship between the arsenic concentration in well water and the mortality for bladder, lung, liver, and kidney cancer." Prior to Chen's work, there was little evidence of systemic cancers associated with ingestion of arsenic. Chen has also found an increase of ischemic heart disease in the area of chronic arsenic exposure.

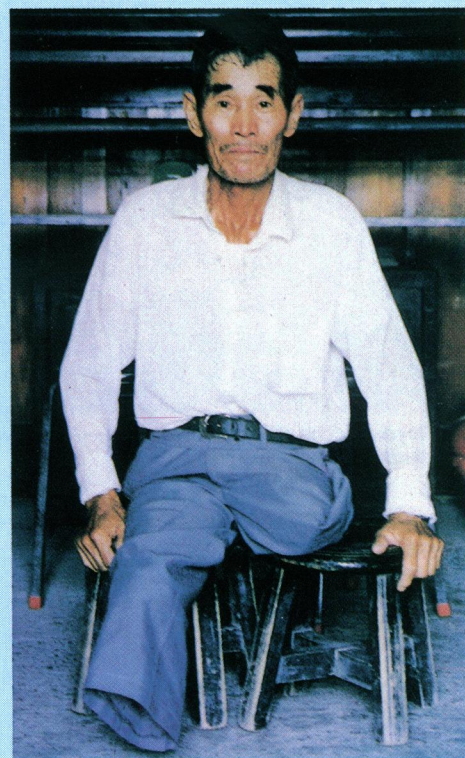
The levels of arsenic in drinking water on the southwest coast of Taiwan ranged from 170 to 800 micrograms per liter ($\mu\text{g/l}$), compared to the current Taiwan and EPA standards of 50 $\mu\text{g/l}$. In U.S. households the estimated average level of arsenic in drinking water is 2.5 $\mu\text{g/l}$. Based on Chen's cancer mortality data, University of California-Berkeley epidemiologist Allan Smith calculated a very high risk (1/1000) of someone dying from cancer during his or her lifetime from drinking water at the 2.5 $\mu\text{g/l}$ level.

Chen and colleagues have turned their attention to Ilan County, which also has elevated arsenic levels and where cases of blackfoot disease recently were identified. They are conducting molecular epidemiology studies in hopes of answering questions about the mechanism of arsenic-induced carcinogenesis by looking at arsenic-induced biomarkers, including chromosome aberrations and sister chromatid exchanges.

Chen is taking diet and exposure histories to determine the role, if any, that malnutrition plays in the increased cancer incidence in blackfoot areas. In southwestern Taiwan, residents historically have eaten a low-protein diet consisting mostly of rice and sweet potatoes.

In collaboration with Chen, University of California toxicologist John Froines and doctoral student Hsu Kuang-Hung are conducting case-control and cohort studies with biological monitoring to investigate the relationship between arsenic dose, arsenic valence state, metabolism, and systemic cancers. In Ilan County they are collecting urine samples and well water to determine the relationship between levels of urinary metabolites of arsenic and the water's arsenic level, as well as assessing variability in metabolism.

The Deputy Director of Taiwan's EPA, Lin Ta Hsuing, said that the agency's policy is to provide tap water to communities with excessive arsenic in well water. In southwestern Taiwan, nearly all urban residents now receive tap water, although 15–20% of rural residents still use potentially contaminated well water.



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Aflatoxin, Hepatitis, and Liver Cancer

For years scientists have asked questions about the role environmental factors may play in the high incidence of liver cancer in China, where primary liver cancer, which is rare in the United States, is the third leading cause of cancer mortality. Now a team of investigators in the United States and China believe they have an answer: dual exposure to a common mold and to a virus that seems to magnify the risk of liver cancer.

Millions of Chinese people are exposed to aflatoxin, a mold long suspected of being a liver carcinogen, and millions more (sometimes simultaneously) are chronically infected with hepatitis B, considered a leading cause of hepatocellular carcinoma. In a major international research effort, scientists have conducted landmark studies to sort out the role each of these risk factors plays in the high liver cancer mortality in China.

The international team consists of researchers from the University of Southern California (USC), Johns Hopkins University, MIT, and the Shanghai Cancer Institute. Their ambitious effort, begun in 1986, is following more than 18,000 men living in four areas of Shanghai to detect new cases of liver cancer as they develop. By March of 1990, 22 cases of primary liver cancer had been detected.

At the beginning of the study in 1986, urine samples were collected from all participants. By using newly developed biomarker assays, the researchers were able to look for urinary aflatoxin metabolites and DNA adducts. Subjects who later developed liver cancer were more likely than controls to have detectable levels of aflatoxin, its metabolites, and DNA adducts in their urine. The subjects were also tested for the hepatitis B surface antigen (HBsAg); those who developed liver cancer were much more likely than controls to be positive. Dramatic relative risk results were found. The chance of getting liver cancer doubled for men testing positive exposed only to aflatoxin biomarkers. The chance increased five times if positive only for hepatitis B, and the risk of liver cancer increased by 60 times among men positive for both aflatoxin and hepatitis B biomarkers.

The team's paper, published in *Lancet* 18 April 1992, demonstrated the importance of the aflatoxin-DNA adduct to liver cancer. Mimi Yu of USC and John Groopman of Johns Hopkins University said the study team has now detected more than 50 cases of liver cancer in the group being followed, and the relative risks remain consistent.

Says Groopman, "As a long-term public health measure, hepatitis B vaccinations will help reduce the toll of liver cancer in China. But in the short-term we need to design a strategy to deal with the aflatoxin expo-



He Xingzhou (right) with student Lan Qing—Women who cook and spend more time in the home may be at greater risk from smoky coal.

hepatitis A in a 2-month period in Shanghai in 1988. Industrial discharges further contaminate water supplies.

The 1992 NEPA report labels river after river as "seriously polluted." The most frequently named pollutants are ammonia nitrogen, volatile phenols, heavy metals, arsenic, cyanides, petrol pollutants, and oxygen-causing organic matter. NEPA notes that nearly 2 million pounds of arsenic and 130 million pounds of "petrol pollutants" were discharged into rivers in 1992. In freshwater lakes, pollution by heavy metals such as mercury and hexavalent chromium is quite serious. Elevated levels of mercury have been detected in fishermen eating mercury-contaminated fish.

Arsenic and fluoride also occur naturally in water supplies in certain provinces of China. At high levels in drinking water, both can be harmful. NEPA authorities say that these two elements are not a national priority because they are found at excessive levels in only a few rural provinces. Chinese scientists, however, say arsenic and fluoride in water, as well as in air, can cause devastating effects on rural residents.

Arsenic contamination. China's arsenic standard for drinking water is the same as EPA's: 50 $\mu\text{g}/\text{m}^3$. Niu has received reports from Inner Mongolia and Xinjing Province that the standard may be exceeded by 10–100 times in drinking water. He is attempting to validate the analytical techniques used in these remote areas.

Scientists from the United States, Taiwan, and China are all exploring potential collaborative projects in Inner Mongolia

to study arsenic exposures and evaluate health effects. Evidence is too preliminary, says Niu, to know if there are internal cancers such as those reported by C.J. Chen and colleagues in Taiwan, although a small number of cases of skin lesions (keratoses) and blackfoot disease, a gangrenous circulatory problem previously documented in Taiwan, have been detected (see box).

Excess fluoride. Millions of Chinese villagers drink water containing high levels (4–10 ppm) of naturally occurring fluoride. Scientists Cao Shouren, Liang Chaoke, and others from the Chinese Academy of Preventive Medicine's Institute of Environmental Health and Engineering are collaborating with George Stookey of Indiana University School of Dentistry on a study of two rural Chinese counties. In the Chinese counties studied, none of the residents drinking low-fluoride water (upper limit of 1 ppm) had evidence of skeletal fluorosis; 87% of villagers drinking high fluoride water (4 ppm) did. In some of the rural areas with the highest fluoride levels, the local government has been purifying the drinking water.

Because U.S. residents do not experience skeletal fluorosis at levels of 4 ppm (the current EPA ceiling), the studies now are examining whether malnutrition (especially lack of protein and calcium) can exacerbate the effects of fluoride.

This study benefits from having subjects who have been living in the same counties, drinking from the same water supply, and eating a similar diet for more than 40 years.

tures." He observes that residents cannot simply avoid aflatoxin because in many areas staple foods are nearly always contaminated with the mold. The study estimated that most aflatoxin exposure is probably from peanuts and soybeans.

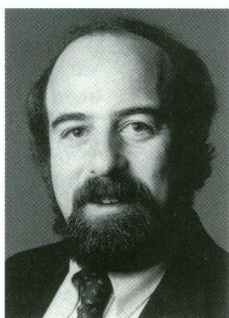
Groopman and colleagues are now looking at 7000 food samples collected in Qidong, north of Shanghai, which also has a high liver cancer rate. "Residents will be examined for adduct formation in serum albumin and for excretion of DNA adducts in urine at the high point of their annual exposure to aflatoxin—post harvest," says Groopman. Groopman said that he hopes the Qidong study "will be a prelude to a possible human liver cancer chemoprevention trial of a drug called Oltipraz," adding that in an experimental study with rats, Oltipraz protected against aflatoxin-induced liver tumors. The aflatoxin biomarkers can be used as intermediate endpoints to assess the protective capabilities of the drug.

Environmentalists in China

China's environmental movement is in its infancy, although some individuals voice opposition to government environmental policies. One of the most vocal environmentalists is Dai Qing, a journalist whose main target has been the Three Gorges Dam, a huge hydroelectric project that will dam the Yangtze River and displace one million residents. Before the Tiananmen Square demonstrations in 1989, Dai published a book of essays opposing the dam project. After the uprising, she was imprisoned for 10 months as a dissident, and her environmental writings were banned.

"Even though we see terrible changes and degradation of the environment with our own eyes, we can't do anything," says Dai. "We cannot express ourselves. Most towns have no elections, so you can't even vote out a government official who is allowing pollution." Dai continued, "If a typical factory manager is successful producing more goods at less cost, the central government will promote him. He has no incentive to think about his responsibility to protect nature." Worst of all, she says, "the common people don't have the strength to organize against pollution."

When they do, it sometimes has tragic results. An Associated Press report last summer described a clash between residents of Lanzhou and workers at a chemical plant. Local government authorities had ordered the plant closed because it was poisoning the water and air with sulfuric acid and carbon disulfide. When the order was ignored,



John Groopman—China needs a plan to confront aflatoxin exposure.

Johns Hopkins

angry residents blocked trucks going into the factory. News reports say the residents got into a clash with chemical workers from the plant, and two residents were killed.

International Assistance

Monetary assistance, in the form of loans, is pouring into China to help solve environmental problems. For example, the British Overseas Development Agency is developing a 20-year environmental protection plan for the city of Taiyuan. In Benxi, the World Bank is replacing indoor coal-burning heaters and supplying energy to residents by means of a centralized district heating system using piped hot water. Smokestacks will help vent cooking emissions. The World Bank is also installing emission controls for the central plant and for nearby coke ovens.

China has become increasingly visible at international gatherings on global environmental matters. China participated in the UN Conference on Environment and Development (the Earth Summit) held in Rio de Janeiro in 1992 and subsequently approved an environmental strategy for China, embodied in a set of guidelines called "Priority Activities for Sustainable Development." Priority activities include abating the pollution from smoke dust, limiting the burning of raw coal powder, vigorously developing central heating, and extending the use of coal briquettes with higher efficiency and lower emission of pollutants for industrial and domestic use, as well as intercepting municipal wastewater from being discharged directly into water bodies and treating it in a centralized manner.

In a report presented at the Earth Summit entitled *1992 National Reports of the People's Republic of China on Environment and Development*, China voiced its commitment to "proper management of the nation's environment

and to making a positive contribution to global environmental protection." The report also made a plea to the more developed nations of the world: "China is a developing country and her current efforts . . . to protect the environment are faced with severe constraints of inadequate funds and lack of advanced . . . technologies. We are hoping that . . . assistance by the international community will be forthcoming."

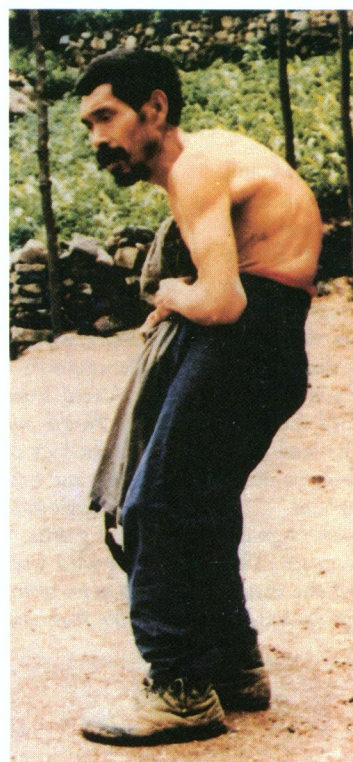
In addition to monetary assistance, China looks to the international community, in particular U.S. universities, to train many of its best science and technology students. The journal *Science* reported 15 October 1993 that a large fraction of the more than 2500 science and engineering PhDs annually awarded to Chinese citizens are from U.S. universities (with a downside that fewer than half of those plan to return to China). The National Institutes of Health also provides postdoctoral scientists from China an opportunity to conduct one to two years of research while visiting the United States. In November 1993, 299 Chinese scientists were at NIH

facilities sharing their expertise and learning to use NIH research methods and equipment for their own studies.

Even with such international assistance, ultimately it will require tremendous effort and commitment by China to meet the environmental protection goals the country set for itself at the Earth Summit in Rio. The country's largest obstacle to achieving environmental protection is its simultaneous commitment to economic progress, laid out in the same Earth Summit presentation: "As a developing country, China must unswervingly give first priority to her national economic development. . . . Environmental protection . . . must serve the purpose of promoting economic progress and improving the quality of life."

Therein lies the challenge facing the most populous country on earth.

Andrea Hricko



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The bad side of fluoride. Researchers say in some villages nearly all adults suffer skeletal fluorosis.

Andrea Hricko has previously written for *EHP* about arsenic.